PATENT ABSTRACTS OF JAPAN

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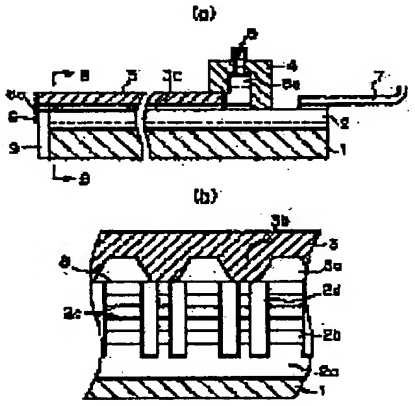
(71)Applicant : RICOH CO LTD
(72)Inventor : HIRANO MASANORI
HORIIE MASANORI
ICHIKAWA KENICHI

(54) INK JET HEAD

(57)Abstract:
PURPOSE: To remove the heat strain or deformation generated from the difference in the coefficient of linear expansion between members at the time of operation.
CONSTITUTION: In an ink jet head injecting ink droplets by the pressure waves generated by pressing a plurality of parallel passages 3a having nozzles 6a by the piezoelectric strain of piezoelectric element 2, the substrate member of the substrate 1 having the piezoelectric element 2 becoming a drive part fixed thereto is constituted of the same material as the piezoelectric element 2 to eliminate mutual thermal expansion difference or constituted of ceramics having the coefficient of linear expansion near to that of the piezoelectric element 2 being the drive part. Further, as the ceramics, one having heat conductivity higher than that of the substrate member, for example, stainless steel is used and the heat diffusion of the substrate during use is improved to enhance the heat stability of the substrate.



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CLAIMS

[Claim(s)]
[Claim 1] The passage plate which has two or more passage which has spacing to each mutually and was arranged in it in parallel to the longitudinal direction of the passage where the nozzle was connected, In the ink jet head which consists of the piezoelectric device used as the mechanical component which changes the volume of said passage and makes ink inject from said nozzle with a variation rate, and the substrate which carries out junction immobilization of this piezoelectric device this passage plate -- joining -- piezo-electricity -- Said substrate is an ink jet head characterized by coefficient of linear expansion considering as the coefficient of linear expansion of said piezoelectric device, an EQC, or the substrate member of the coefficient of linear expansion near it.
[Claim 2] The ink jet head according to claim 1 characterized by making said substrate member into ceramic material.
[Claim 3] The ink jet head according to claim 2 characterized by making the thermal conductivity of the ceramic material as said substrate member into 2-7 kcal/mhdegree C near ordinary temperature.
[Claim 4] The ink jet head according to claim 1 characterized by using said substrate member as the same material as the piezoelectric device of said mechanical component.
[Claim 5] The ink jet head according to claim 4 characterized by calcinating said substrate member to which said substrate member and piezoelectric device were really fabricated, and were really fabricated for the same material, and a piezoelectric device.
[Claim 6] The passage plate which has two or more passage which has spacing to each mutually and was arranged in it in parallel to the longitudinal direction of the passage where the nozzle was connected, In the ink jet head which consists of the piezoelectric device used as the mechanical component which changes the volume of said passage and makes ink inject from said nozzle with a variation rate, and the substrate which carries out junction immobilization of this piezoelectric device this passage plate -- joining -- piezo-electricity -- The ink jet head characterized by making into the piezoelectric device of a mechanical component, an EQC, or the coefficient of linear expansion near it coefficient of linear expansion of the passage member which constitutes said passage.
[Claim 7] The ink jet head according to claim 6 characterized by using said passage member as silicon.
[Claim 8] The ink jet head according to claim 6 characterized by making coefficient of linear expansion of said passage member and substrate member into the coefficient of linear expansion near a piezoelectric device.
[Claim 9] The ink jet head according to claim 7 characterized by using said passage member and substrate member as the same material.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] About an ink jet head, more, even when environmental temperature changes to a detail or long duration use is carried out, the formation of a form status change and distorted generating of this invention are small, injection of an ink droplet is stabilized, and it relates to the material configuration of the head from which the printing image of high quality is obtained.
[0002]
[Description of the Prior Art] The ink jet head of a mold on demand generates a pressure wave in the passage which has an injection nozzle, is based on the principle which makes the ink of a complement inject as a drop by this pressure wave, and only when required for record, it is a head for record which makes ink inject.
[0003] The fundamental ink jet head (it is only henceforth called a head) of a mold on demand The nozzle plate which has two or more nozzles, and the passage plate which has two or more parallel passage which attaches this nozzle plate at a tip and is open for free passage in the common liquid room of ink, According to the parallel passage of a passage plate, it has two or more slots, and consists of a piezoelectric device for giving a piezo-electric distortion to the passage which corresponds according to a picture signal, generating a pressure wave, and making an ink droplet inject from a nozzle, and a substrate which fixes and supports this piezoelectric device. Although the miniaturization and the high definition are advanced also in the ink jet printer in recent years, in manufacture of the head which consists of two or more members, all have depended most junction between members on adhesives. However, on the class of member to join, and the relation of bonding strength, most are heat-curing mold adhesives, such as an epoxy system, and, as for the adhesives to be used, heat-treatment in the thermostatic oven etc. is inevitably performed in a head manufacture process.
[0004] Drawing 6 (a) and (b) are drawings showing the bonded structure of a piezoelectric device and a substrate, and the piezoelectric device 11 and the substrate 12 have fixed them with the heat-curing mold adhesives 13 of an epoxy system. However, if stainless steel (henceforth referred to as SUS) is used, and it is plate-like mutually before adhesion as shown in the (a) Fig., but a piezoelectric device 11 and a substrate 12 heat the substrate 12 of the conventional ink jet head in order to carry out heat curing of the adhesives 13, for a differential thermal expansion, as shown in the (b) Fig., it will curve, and will fix in this condition. Thus, when the coefficient of linear expansion of the members to join differs greatly, in case it is heat-curing processing, deformation and distortion are produced, and there is a possibility of hardening as it is. In a manufacture process, the bonding strength of about [becoming the error of a trim size] and a joint will fall, and such distortion and deformation will cause the situation of exfoliating further.
[0005] Moreover, thermal distorted generating of a head is produced at the time of a head drive. That is, a piezoelectric device emits heat by the energy at the time of a drive, calorific value is proportional to the number of nozzles to drive, and drive time amount, and temperature becomes high according to calorific value. Drawing 7 is a graph which shows the relation of the amount of displacement by the skin

temperature of the piezoelectric device to head drive time amount, and the thermal expansion at a head tip, and deformation of a head also becomes large in connection with this temperature rise. Although the temperature rise produced by injection of ink is reaching the ceiling in a certain amount of place, and a deformation degree is small compared with the time of heat hardening and it ends, considering that deformation takes place at every drive, it becomes a problem considerably in respect of the injection stability of ink, or the long-term dependability of a head.
[0006]
[Objects of the Invention] This invention was made in view of the above-mentioned actual condition, and aims at removing un-arranging [which is produced at the time of employment] in the list on the process which happens from the difference in the coefficient of linear expansion of the member which constitutes a head. Most, by using the piezoelectric device from which deformation poses a problem, and a substrate and the member to which it had the coefficient of linear expansion near a piezoelectric device in the list paying attention to the piezoelectric device and the passage plate, deformation and distortion are reduced and, specifically, improvement in injection stability is aimed at in the quality list of a head.
[0007]
[Elements of the Invention] The passage plate which has two or more passage which has spacing in (1) of each mutually, and was arranged in it in parallel to the longitudinal direction of the passage where the nozzle was connected in order that this invention might attain the above-mentioned purpose, In the ink jet head which consists of the piezoelectric device used as the mechanical component which changes the volume of said passage and makes ink inject from said nozzle with a variation rate, and the substrate which carries out junction immobilization of this piezoelectric device this passage plate -- joining -- piezo-electricity -- coefficient of linear expansion used said substrate as the coefficient of linear expansion of said piezoelectric device, the EQC, or the substrate member of the coefficient of linear expansion near it -- further (2) -- having made said substrate member into ceramic material in the above (1) -- further (3) -- having made the thermal conductivity of the ceramic material as said substrate member into 2-7 kcal/mhdegree C near ordinary temperature in the above (2) -- further (4) -- having used said substrate member as the same material as the piezoelectric device of said mechanical component in the above (1) -- further (5) -- having calcinated said substrate member to which said substrate member and piezoelectric device were really fabricated, and were really fabricated for the same material in the above (4), and the piezoelectric device -- or (6) The passage plate which has two or more passage which has spacing to each mutually and was arranged in it in parallel to the longitudinal direction of the passage where the nozzle was connected, In the ink jet head which consists of the piezoelectric device used as the mechanical component which changes the volume of said passage and makes ink inject from said nozzle with a variation rate, and the substrate which carries out junction immobilization of this piezoelectric device this passage plate -- joining -- piezo-electricity -- having made into the piezoelectric device of a mechanical component, an EQC, or the coefficient of linear expansion near it coefficient of linear expansion of the passage member which constitutes said passage -- further (7) -- having used said passage member as silicon in the above (6) -- further (8) In the above (6), it is further characterized by to have made coefficient of linear expansion of said passage member and substrate member into the coefficient of linear expansion near a piezoelectric device, and using said passage member and substrate member as the same material in (9) above (7). Hereafter, it explains based on the example of this invention.
[0008] Drawing 1 (a) and (b) are drawings for explaining an example of the structure of the ink jet head concerning this invention. drawing (a) -- a sectional side elevation and the (b) Fig. -- the partial diagrammatic view of the B-B line view sectional view of the (a) Fig. -- being shown -- the inside of drawing, and 1 -- a substrate and 2 -- a piezoelectric device and 3 -- for an ink feed hopper and 6, as for a printed circuit board (FPC) and 8, a nozzle plate and 7 are [a passage plate and 4 / a common liquid room and 5 / an up septum and 9] guard plates.
[0009] The head shown in drawing 1 carries out thermocompression bonding of the substrate 1 which is equal to the coefficient of linear expansion of a piezoelectric device 2, or is in abbreviation etc. by carrying out, and consists of a material of coefficient of linear expansion with thermosetting epoxy

system resin, and joins. The piezoelectric device 2 is divided into non-driving piezoelectric-device 2a and drive piezoelectric-device 2b by 2d (space) of two or more slots parallel to a longitudinal direction. He is trying for a deformation amount to become large to the same applied voltage by making thin thickness of the piezoelectric device which a piezoelectric device 2 is the thing of a laminating mold, and has and drives beforehand electrode 2c parallel to a substrate 1 by which parallel connection was carried out. FPC7 is connected to a piezoelectric device 2 so that a drive power source may be impressed only to electrode 2c of drive piezoelectric-device 2b.

[0010] Each drive piezoelectric-device 2b counters with two or more passage 3a of each parallel to the longitudinal direction of the passage plate 3, and is joined through the up septum 8. The end of passage 3a is open for free passage in the common liquid room 4 which has the ink feed hopper 5, supply of ink is received, and the nozzle plate 6 which has nozzle 6a corresponding to each passage 3a in the other end is joined with the guard plate 9.

[0011] Thus, if drive piezoelectric-device 2b drives the constituted head with the electrical potential difference impressed through FPC7 from the drive power source according to a picture signal and a piezo-electric distortion arises, corresponding passage 3a will be compressed, a pressure wave will generate it, and an ink droplet will be injected from nozzle 6a. Next, the head constituted in this way explains the example which this invention it is made for a thermal strain not to receive constituted and illustrated including the cure with which it was carried out conventionally for a comparison.

[0012] Drawing 2 (a), (b), and (c) are drawings for explaining a difference of the cure at the time of the heat hardening of the piezoelectric device of the former and this invention and a substrate, and the cure according [the cure of the former / Fig. / (a) / and the (b) Fig.] to this invention and the (c) Fig. explain the distorted generating situation by this invention.

[0013] (a) As the cure against deformation at the time of the conventional heat hardening shown in drawing, a thermosetting epoxy resin is applied to the top face of the SUS substrate 12, a piezoelectric device 2 is carried, and a top face is further covered with the epoxy resin and high-melting silicon rubber sheet 14 which are hard to paste up by elastic material, and the pressure plate 17 of a fixture 15 tends to be ****ed, 16 tends to be rotated, regularity tends to bind tight, and it is going to pressurize equally by **, and is going to prevent deformation elastically. However, by this approach, since it is joined while considerable stress had started internally although deformation is not seen in appearance, since it is fixed to the fixture, it may deform, just as it removes a fixture 15, and exfoliation for the joint of a piezoelectric device 2 and SUS substrate 1a may arise depending on the case.

[0014] On the other hand, the (b) Fig. by this invention is an example when using a ceramic for the substrate member 1. Although a ceramic has the thing of various components, such as an alumina, and barium titanate or silicon nitride, by the application, coefficient of linear expansion is 0.5 - 10x10-6/degree C, and shows the value quite near coefficient-of-linear-expansion [of a piezoelectric device 2] 2 - 4x10-6/degree C compared with 10 - 20x10-6/degree C of metals, such as SUS. Distortion and deformation which come from the difference of coefficient of linear expansion as shown in the (c) Fig. can be suppressed to min by choosing that to which a difference with the coefficient of linear expansion of the piezoelectric device 2 to be used becomes the smallest from such inside. That is, since a piezoelectric device 2 and a ceramic substrate 1 are in **** etc. by making it an arrow head L1 and L 2-way to unit length respectively and the thermal expansion of die length arises, shearing stress does not carry out ****** generating in the plane of composition of a piezoelectric device 2 and the ceramic substrate 1, therefore it does not curve.

[0015] Furthermore, if coefficient of linear expansion is equipped with sufficient reinforcement and rigidity to use it for the piezoelectric device 2 for a drive as near and a substrate and is clear and is, it is possible at other members. For example, silicon etc. is coefficient-of-linear-expansion 2.8 - 7.3x10-6/degree C, and shows the value still nearer to the coefficient of linear expansion of a piezoelectric device 2 rather than the ceramic. Furthermore, if you want to make the difference of coefficient of linear expansion into zero completely again, it will be using a substrate 1 as the same material as a piezoelectric device 2.

[0016] Drawing 3 (a) and (b) are drawings for explaining other examples of the ink jet head by this

invention, and the (a) Figs. are a substrate and a form according to piezoelectric device, the (b) Figs. are a substrate and piezoelectric-device one apparatus, and they give the same reference number as drawing 1 to the same part as drawing 1 which acts.
[0017] (a) Drawing is what formed the quality of the material of a substrate 1 in another object as the same piezoelectric device as the piezoelectric device 2 which is a mechanical component, and joined each, and there is no coefficient-of-linear-expansion difference. Thus, although it is realizable by using the piezoelectric device 2 used for the mechanical component also as a material of a substrate 1, heating junction of the piezoelectric device 2 and substrate 1 of a mechanical component must be carried out with a heat-curing epoxy resin in this case. However, even if it does not carry out heating junction, the part which is equivalent to the member of a substrate 1 in the phase of calcinating a piezoelectric device 2 as shown in the (b) Fig. can also be made together.
[0018] As mentioned above, respectively, although it explained making small a coefficient-of-linear-expansion difference with a piezoelectric device 2, and preventing the heat deformation at the time of junction and use by using a ceramic as material of a substrate 1, since the heat dissipation from a substrate 1 will be promoted if higher than the thermal conductivity of a piezoelectric device 2 and SUS whose thermal conductivity of this ceramic substrate 1 is the conventional substrate material equally, coefficient of linear expansion can consider as the head stabilized more.
[0019] Drawing 4 is drawing showing the thermal conductivity of various ingredients, and if it is the ceramics of the thermal conductivity higher than SUS near the ordinary temperature, its heat dissipation effectiveness is large. Generation of heat at the time of a head drive can be controlled by heat dissipation of a substrate like a metal substrate by choosing what used silicon carbide and an alumina as the principal component as ceramics with high thermal conductivity, and using this in ordinary temperature. Furthermore, it can say that rank **** of an ingredient are the same also about the passage plate 3 from problems, such as ******.
[0020] Drawing 5 is drawing for explaining other examples of the ink jet head by this invention, and if the passage plate 3 and a substrate 1 are created with the same material, for example, silicon, as shown in drawing, the thermal-expansion effect of a piezoelectric device 2, the passage plate 2, and a substrate 1 not only becomes small, but it can suppress considerably the distortion and deformation of a piezoelectric device 2 by vibration.
[0021]
[Effect] According to this invention, there is the following effectiveness so that clearly from the above explanation.
(1) Effectiveness corresponding to claims 1-9 : since distortion and deformation which take place from the difference in the coefficient of linear expansion of a member are controlled, the precision and the yield of a head become good. Moreover, since ink injection stability also becomes good, stable injection of ink is attained also on severe drive conditions, such as a drive with the high voltage or high frequency, and a drive by high temperature.
(2) Effectiveness corresponding to claim 2 : since the coefficient of linear expansion very near a piezoelectric device is shown, a ceramic tends to expect the above-mentioned effectiveness, and since it is more nearly lightweight than a metal, it can attain lightweight-ization of the head itself.
(3) Effectiveness corresponding to claim 3 : generation of heat of the piezoelectric device at the time of a head drive can be eased from circulation of ink and both sides of the heat dissipation from a substrate, and effect of the head configuration member on drive generation of heat can be made small.
(4) Effectiveness corresponding to claim 4 : the junction process of a piezoelectric device and a substrate in a head work process can be skipped, and a head can be created with the smaller number of components.
(5) Effectiveness corresponding to claim 9 : since it is the thing of the completely same quality of the material and a piezoelectric device is put, distortion and deformation can be suppressed rather than the time only of a passage plate or a substrate.

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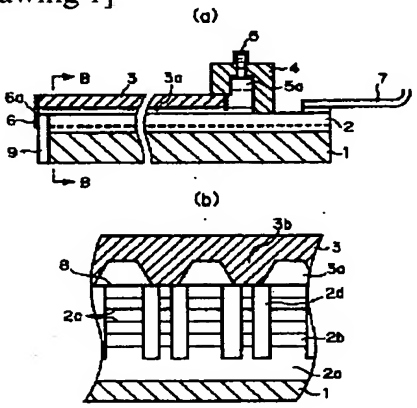
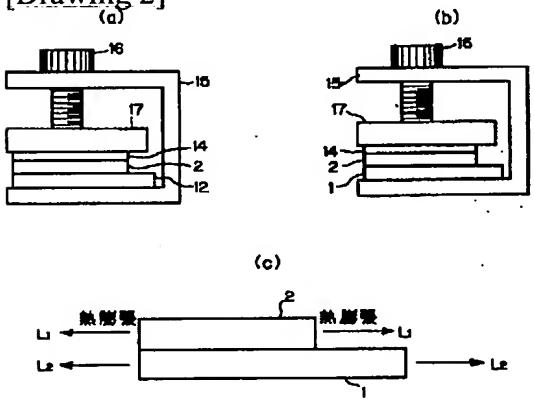
DRAWINGS

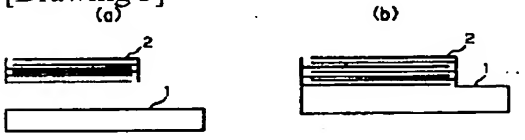
[Drawing 1]



[Drawing 2]



[Drawing 3]



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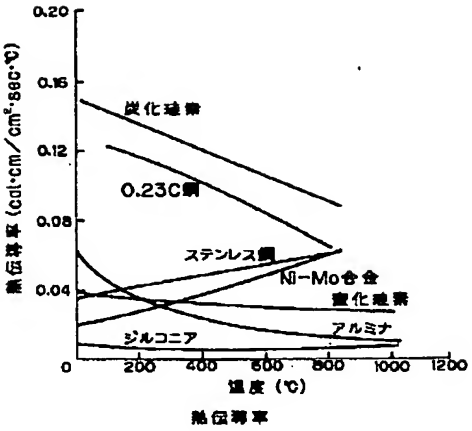

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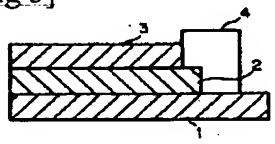

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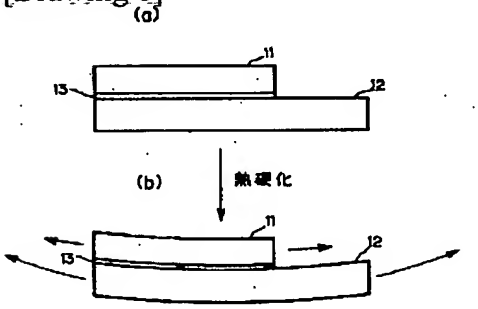
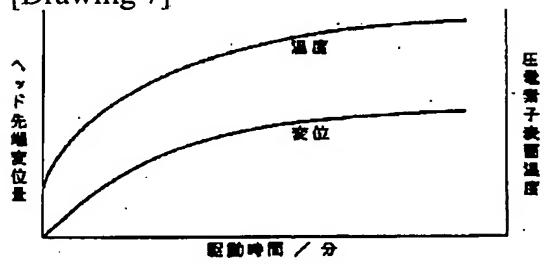


[Drawing 7]



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(71)出願人　000006747
株式会社リコー
東京都大田区中馬込１丁目３番６号

(72)発明者　平野　政徳
東京都大田区中馬込１丁目３番６号　株式会社リコー内

(72)発明者　堀家　正紀
東京都大田区中馬込１丁目３番６号　株式会社リコー内

(72)発明者　市川　憲一
東京都大田区中馬込１丁目３番６号　株式会社リコー内

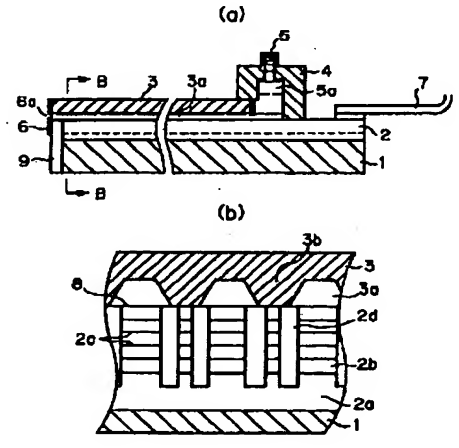
(74)代理人　弁理士　高野　明近　（外１名）

(54)【発明の名称】　インクジェットヘッド

(57)【要約】

【目的】　部材の線膨張係数の違いから起こる工程上、並びに運用時に発生する熱ひずみや変形が生ずるのを除く。

【構成】　各々ノズル６ａを有する複数の平行流路３ａを圧電素子２の圧電歪により押圧して発生する圧力波によりインク滴を噴出するインクジェットヘッドにおいて、駆動部となる圧電素子２を固着する基板１の基板部材を圧電素子２と同一の圧電素子で構成して相互の熱膨張差をなくするか、駆動部の圧電素子２の線膨張係数に近い線膨張係数のセラミックスにする。更には、セラミックスでも基板部材、例えばステンレス鋼よりも熱伝導率が高いセラミックスとして使用中の熱放散をよくし熱安定性を向上させる。



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【特許請求の範囲】

【請求項１】　各々にノズルが接続された流路の長手方向に対し、互いに間隔を有して平行に配設された複数の流路を有する流路板と、該流路板と接合し、圧電変位によって前記流路の容積を変化させ、インクを前記ノズルから噴射させる駆動部となる圧電素子と、この圧電素子を接合固定する基板とから成るインクジェットヘッドにおいて、前記基板は、線膨張係数が前記圧電素子の線膨張係数と同等若しくはそれに近い線膨張係数の基板部材としたことを特徴とするインクジェットヘッド。

【請求項２】　前記基板部材をセラミック材としたことを特徴とする請求項１記載のインクジェットヘッド。

【請求項３】　前記基板部材としてのセラミック材の熱伝導率を常温付近で２～７ｋｃａｌ／ｍｈ℃としたことを特徴とする請求項２記載のインクジェットヘッド。

【請求項４】　前記基板部材を前記駆動部の圧電素子と同じ素材としたことを特徴とする請求項１記載のインクジェットヘッド。

【請求項５】　前記基板部材と圧電素子とを同一素材で一体成形し、一体成形した前記基板部材と圧電素子を焼成したことを特徴とする請求項４記載のインクジェットヘッド。

【請求項６】　各々にノズルが接続された流路の長手方向に対し、互いに間隔を有して平行に配設された複数の流路を有する流路板と、該流路板と接合し、圧電変位によって前記流路の容積を変化させ、インクを前記ノズルから噴射させる駆動部となる圧電素子と、この圧電素子を接合固定する基板とから成るインクジェットヘッドにおいて、前記流路を構成する流路部材の線膨張係数を、駆動部の圧電素子と同等若しくはそれに近い線膨張係数としたことを特徴とするインクジェットヘッド。

【請求項７】　前記流路部材をシリコンとしたことを特徴とする請求項６記載のインクジェットヘッド。

【請求項８】　前記流路部材と基板部材の線膨張係数を圧電素子に近い線膨張係数としたことを特徴とする請求項６記載のインクジェットヘッド。

【請求項９】　前記流路部材と基板部材を同一素材としたことを特徴とする請求項７記載のインクジェットヘッド。

【発明の詳細な説明】

【０００１】

【技術分野】本発明は、インクジェットヘッドに関し、より詳細には、環境温度が変化したり、長時間使用した場合でも形状変化や歪の発生が小さく、インク滴の噴射が安定し、高品質の印字画像が得られるヘッドの素材構成に関する。

【０００２】

【従来技術】オンデマンド型のインクジェットヘッドは、噴射ノズルを有する流路内に圧力波を発生させ、この圧力波により必要な量のインクを液滴として噴射させる原理に基づいており、記録に必要なときのみインクを噴射させる記録用のヘッドである。

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【０００３】基本的なオンデマンド型のインクジェットヘッド（以後単にヘッドと呼ぶ）は、複数のノズルを有するノズル板と、このノズル板を先端に取り付け、インクの共通液室に連通する複数の平行な流路を有する流路板と、流路板の平行な流路に応じて複数の溝を有し、画像信号に従って該当する流路に対し圧電歪を与えて圧力波を発生させノズルからインク滴を噴射させるための圧電素子と、この圧電素子を固定し支える基板とから構成される。近年、インクジェットプリンタにおいても小型化、高精細が進められているが、複数の部材から構成されるヘッドの製作において、部材間の接合は殆ど全てが接着剤によるものになっている。しかし、接合する部材の種類、及び接合強度の関係上、使用する接着剤はほとんどがエポキシ系等の熱硬化型接着剤であり、必然的にヘッド製作工程の中で恒温炉等での加熱処理が行われる。

【０００４】図６（ａ）（ｂ）は、圧電素子と基板との接着構造を示す図で、圧電素子１１と基板１２とは、エポキシ系の熱硬化型接着剤１３で固着されている。しかし、従来のインクジェットヘッドの基板１２は、例えば、ステンレス鋼（以後ＳＵＳと呼ぶ）が使用され、圧電素子１１と基板１２とは接着前は（ａ）図のように互いに平板状であるが、接着剤１３を熱硬化させるために加熱すると熱膨張差のため（ｂ）図のように湾曲し、この状態で固着される。このように接合する部材同士の線膨張係数が大きく異なると、熱硬化処理の際に変形や歪を生じ、そのまま硬化してしまう恐れがある。このような歪みや変形は、製作工程において仕上り寸法の誤差となるばかりか、接合部の接合強度が低下し、更には剥離するといった事態を引き起こしてしまう。

【０００５】また、ヘッドの熱的な歪発生は、ヘッド駆動時においても生ずる。すなわち、圧電素子は駆動時のエネルギにより熱を発し、発熱量は駆動されるノズル数、及び駆動時間に比例し、発熱量に従って温度が高くなっていく。図７は、ヘッド駆動時間に対する圧電素子の表面温度およびヘッド先端の熱膨張による変位量の関係を示すグラフであり、ヘッドの変形もこの温度上昇に伴って大きくなっていく。インクの噴射によって生ずる温度上昇は、ある程度の所で頭打ちとなり、加熱硬化時に比べると変形度合いは小さくてすむが、駆動の度に変形が起こることを考えると、インクの噴射安定性やヘッドの長期信頼性の点でかなり問題となる。

【０００６】

【目的】本発明は、上述の実情に鑑みてなされたもので、ヘッドを構成する部材の線膨張係数の違いから起こる工程上、並びに運用時に生ずる不都合を除くことを目的としている。具体的には、最も変形が問題となる圧電素子と基板、並びに圧電素子と流路板に注目し、圧電素

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子に近い線膨張係数を持った部材を使用することによって、変形や歪を低減させ、ヘッドの品質並びに、噴射安定性の向上を図るものである。

【０００７】

【構成】本発明は、上記目的を達成するために、（１）各々にノズルが接続された流路の長手方向に対し、互いに間隔を有して平行に配設された複数の流路を有する流路板と、該流路板と接合し、圧電変位によって前記流路の容積を変化させ、インクを前記ノズルから噴射させる駆動部となる圧電素子と、この圧電素子を接合固定する基板とから成るインクジェットヘッドにおいて、前記基板は、線膨張係数が前記圧電素子の線膨張係数と同等若しくはそれに近い線膨張係数の基板部材としたこと、更には、（２）前記（１）において、前記基板部材をセラミック材としたこと、更には、（３）前記（２）において、前記基板部材としてのセラミック材の熱伝導率を常温付近で２～７ｋｃａｌ／ｍｈ℃としたこと、更には、（４）前記（１）において、前記基板部材を前記駆動部の圧電素子と同じ素材としたこと、更には、（５）前記（４）において、前記基板部材と圧電素子とを同一素材で一体成形し、一体成形した前記基板部材と圧電素子を焼成したこと、或いは、（６）各々にノズルが接続された流路の長手方向に対し、互いに間隔を有して平行に配設された複数の流路を有する流路板と、該流路板と接合し、圧電変位によって前記流路の容積を変化させ、インクを前記ノズルから噴射させる駆動部となる圧電素子と、この圧電素子を接合固定する基板とから成るインクジェットヘッドにおいて、前記流路を構成する流路部材の線膨張係数を、駆動部の圧電素子と同等若しくはそれに近い線膨張係数としたこと、更には、（７）前記（６）において、前記流路部材をシリコンとしたこと、更には、（８）前記（６）において、前記流路部材と基板部材の線膨張係数を圧電素子に近い線膨張係数としたこと、更には、（９）前記（７）において、前記流路部材と基板部材を同一素材としたことを特徴とするものである。以下、本発明の実施例に基づいて説明する。

【０００８】図１（ａ），（ｂ）は、本発明に係るインクジェットヘッドの構造の一例を説明するための図で、図（ａ）は側断面図、（ｂ）図は（ａ）図のＢ－Ｂ線矢視断面図の部分図を示し、図中、１は基板、２は圧電素子、３は流路板、４は共通液室、５はインク供給口、６はノズルプレート、７はプリント基板（ＦＰＣ）、８は上部隔壁、９は保護板である。

【０００９】図１に示したヘッドは、圧電素子２の線膨張係数と等しいか、或いは略等しい線膨張係数の素材からなる基板１とを熱硬化性のエポキシ系樹脂により熱圧着して接合したものである。圧電素子２は、長手方向に平行な複数の溝（空間）２ｄにより非駆動圧電素子２ａと駆動圧電素子２ｂとに区切られている。圧電素子２は、積層型のもので予め基板１と平行な並列接続された

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電極２ｃを有し駆動される圧電素子の厚さを薄くすることで同一の印加電圧に対して歪量が大きくなるようにしている。圧電素子２には、駆動圧電素子２ｂの電極２ｃにのみ駆動電源が印加されるようにＦＰＣ７が接続される。

【００１０】各々の駆動圧電素子２ｂは、流路板３の長手方向に平行な複数の各々の流路３ａと対向し上部隔壁８を介して接合される。流路３ａの一端は、インク供給口５を有する共通液室４に連通してインクの供給を受け、他端は各々の流路３ａに対応するノズル６ａを有するノズルプレート６が保護板９とともに接合されている。

【００１１】このように構成されたヘッドは、画像信号に従った駆動電源からＦＰＣ７を介して印加される電圧により駆動圧電素子２ｂが駆動され圧電歪が生ずると、対応する流路３ａは圧縮されて圧力波が発生し、ノズル６ａよりインク滴が噴射される。次に、このように構成されたヘッドが熱歪の受けないようにする本発明の構成及び図示した実施例について、比較のために、従来行われた対策を含めて説明する。

【００１２】図２（ａ），（ｂ），（ｃ）は、従来と本発明との圧電素子と基板との加熱硬化時の対策の相違を説明するための図であり、（ａ）図は従来の対策、（ｂ）図は本発明による対策、（ｃ）図は本発明による歪の発生状況を説明するものである。

【００１３】（ａ）図に示す従来の加熱硬化時の変形対策では、ＳＵＳ基板１２の上面に熱硬化性エポキシ樹脂を塗布して圧電素子２を載せ、更に、上面に弾性材でエポキシ樹脂と接着しにくい高融点のシリコンゴムシート１４を敷き、治具１５の押え板１７をねじ１６を回動し一定の締め付け圧で均等に加圧して、弾性的に変形を防ごうとしている。しかし、この方法では、治具に固定されているために外見的には変形は見られないものの、内部的に相当なストレスがかかったまま接合されるため、治具１５を外した途端に変形し、場合によっては圧電素子２とＳＵＳ基板１ａとの接合部分の剥離が生じることもある。

【００１４】これに対し、本発明による（ｂ）図は、基板部材１にセラミックを使用した時の例である。セラミックは、用途によってアルミナやチタン酸バリウム、あるいは窒化珪素等様々な成分のものがあるが、線膨張係数は０．５～１０×10^{-6}／℃であり、ＳＵＳ等金属の１０～２０×10^{-6}／℃に比べてかなり圧電素子２の線膨張係数２～４×10^{-6}／℃に近い値を示す。こういった中から、使用する圧電素子２の線膨張係数との差が最も小さくなるものを選ぶことによって、（ｃ）図に示す様に線膨張係数の差から来る歪や変形を最小に抑えることができる。すなわち、圧電素子２とセラミック基板１とが、各々矢印L_1とL_2方向に単位長さに対し略々等しい長さの熱膨張が生ずるので、圧電素子２とセラミック

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ス基板１との接合面でずり応力が殆んど発生せず、従って湾曲することもない。

【００１５】更に、線膨張係数が駆動用の圧電素子２に近く、基板として使用するに充分な強度や剛性を備えてさえいるならば、他の部材でも可能である。例えば、シリコンなどは線膨張係数２．８～７．３×１０$^{-6}$／℃であり、セラミックよりも更に圧電素子２の線膨張係数に近い値を示している。更にまた線膨張係数の差を完全に零にしたいのならば、基板１を圧電素子２と同一の素材にすることである。

【００１６】図３（ａ），（ｂ）は、本発明によるインクジェットヘッドの他の実施例を説明するための図で、（ａ）図は基板、圧電素子別体型、（ｂ）図は基板、圧電素子一体型であり、図１と同じ作用する部分には図１と同一の参照番号を付している。

【００１７】（ａ）図は基板１の材質を駆動部である圧電素子２と同一の圧電素子として別体に形成して各々を接合したもので、線膨張係数差はない。この様に、駆動部に使用した圧電素子２を基板１の素材としても使用することによって実現することができるが、この場合には、駆動部の圧電素子２と基板１とを熱硬化エポキシ樹脂で加熱接合しなければならない。しかし、加熱接合しなくても、（ｂ）図に示す様に圧電素子２を焼成する段階で基板１の部材に相当する部分も一緒に作り出すことが可能である。

【００１８】以上、セラミックを基板１の素材とすることにより圧電素子２との線膨張係数差を小さくして、接合時および使用時の熱変形を防止することを説明したが、線膨張係数が圧電素子２と各々等しくこのセラミックス基板１の熱伝導率が、従来の基板材であるＳＵＳの熱伝導率よりも高ければ基板１からの放熱が促進されるのでより安定したヘッドとすることができる。

【００１９】図４は、各種材料の熱伝導率を示す図で、常温近傍でＳＵＳよりも高い熱伝導率のセラミックスであれば放熱効果が大きい。常温で熱伝導率の高いセラミックスとして、例えば、炭化珪素やアルミナを主成分としたものを選んでこれを使用することにより、金属基板と同じようにヘッド駆動時の発熱を基板の放熱によって抑制することが出来る。更には、接液性等の問題から材料は格られるが、流路板３についても同様のことが言える。

【００２０】図５は、本発明によるインクジェットヘッドの他の実施例を説明するための図で、図に示すように流路板３と基板１を同一の素材、例えば、シリコンで作成すれば、圧電素子２と流路板２および基板１の熱膨張

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影響が小さくなるだけでなく、圧電素子２の振動による歪や変形をかなり抑えることができる。

【００２１】

【効果】以上の説明から明らかなように、本発明によれば、以下の効果がある。

（１）請求項１～９に対応する効果：部材の線膨張係数の違いから起こる歪や変形が抑制されるので、ヘッドの精度や歩留まりが良くなる。また、インク噴射安定性も良くなるため、高電圧や高周波数での駆動、高温度での駆動といった厳しい駆動条件でもインクの安定噴射が可能になる。

（２）請求項２に対応する効果：セラミックは圧電素子に非常に近い線膨張係数を示すため、上記効果を期待しやすく、また、金属よりも軽量のため、ヘッドそのものの軽量化が図れる。

（３）請求項３に対応する効果：ヘッド駆動時の圧電素子の発熱をインクの循環と基板からの放熱の両面から緩和し、駆動発熱のヘッド構成部材への影響を小さくすることができる。

（４）請求項４に対応する効果：ヘッド制作工程における圧電素子と基板の接合工程が省け、より少ない部品数でヘッドを作成することができる。

（５）請求項９に対応する効果：圧電素子をまったく同じ材質のもので挟み込むため、流路板もしくは基板だけの時よりも歪や変形を抑えることができる。

【図面の簡単な説明】

【図１】　本発明に係るインクジェットヘッドの構造の一例を説明するための図である。

【図２】　従来と本発明との圧電素子と基板との加熱硬化時の対策の相違を説明するための図である。

【図３】　本発明によるインクジェットヘッドの他の実施例を説明するための図である。

【図４】　各種材料の熱伝導率を示す図である。

【図５】　本発明によるインクジェットヘッドの他の実施例を説明するための図である。

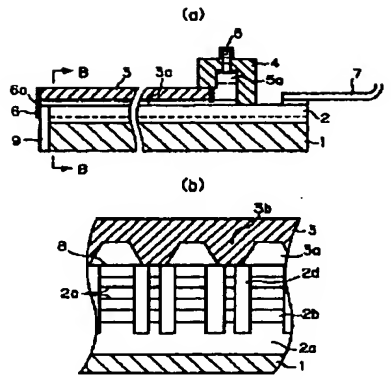
【図６】　圧電素子と基板との接着構造を示す図である。

【図７】　ヘッド駆動時間に対する圧電素子の表面温度およびヘッド先端の熱膨張による変位量の関係を示すグラフである。

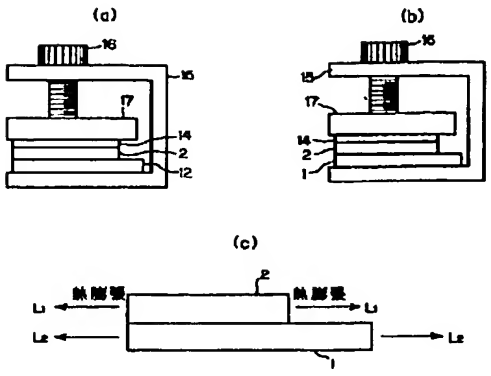
【符号の説明】

１…基板、２…圧電素子、３…流路板、４…共通液室、５…インク供給口、６…ノズルプレート、７…プリント基板（ＦＰＣ）、８…上部隔壁、９…保護板。

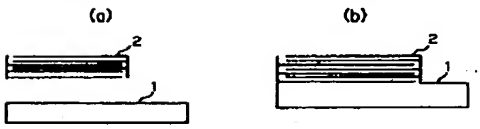
【図１】



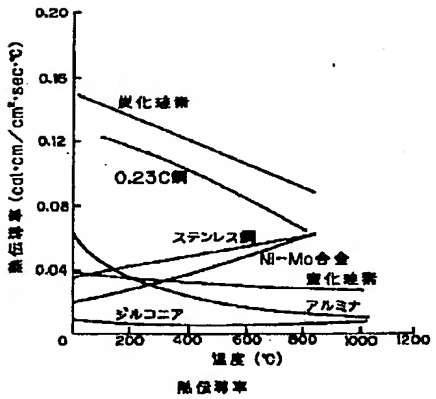
【図２】



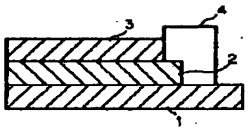
【図３】



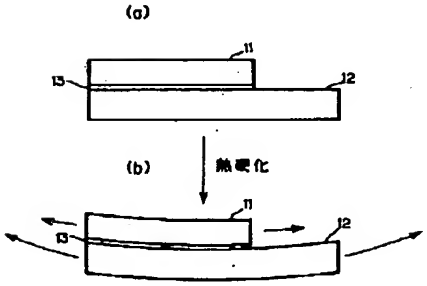
【図４】



【図５】



【図６】



【図７】